§10. Weight Saving and Performance Evaluation of On-Site Radiation Monitoring Cart

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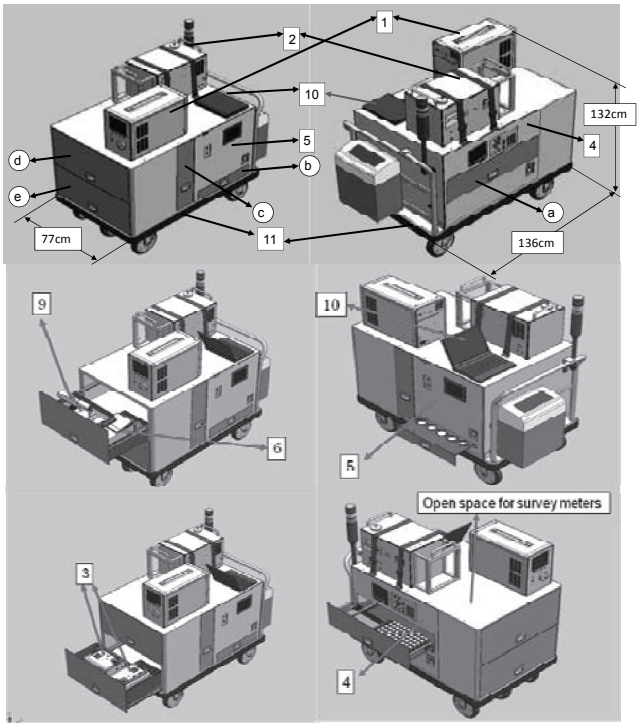
In the previous study, the first on-site radiation monitoring cart was designed as a battery-powered electric cart. The cart was raidable and had a width of 164 cm, a height of 150 cm and a depth of 80 cm. Its weight was 729.5 kg. The dimensions were acceptable as an actual cart, but the mass of the cart was too heavy to move smoothly and safely on the floor. In this study, the cart was redesigned to reduce its weight. For the new design of the cart, (1) the number of samples measured at one time or for a single run were reduced by half, (2) the shielding materials were removed, (3) housing panels were removed and communal panels were attached to the rover rack, (4) the top lid of the superior opening was replaced with drawers, (5) the iterative measurement elements were removed, (6) a detecting element and a measurement element of the Alpha/beta measuring(ABM) system were unified, and (7) the cart was transformed into a pushcart. Thus redesigned monitoring cart is shown in Fig. 1.



1. Tritium gas monitor, 2. Hydrogen and carbon air sampler,
3. Two dust samplers, 4.Liquid scintillation counting (LSC) system,
5. Alpha/beta measuring(ABM) system, 6. Ge spectroscopy system,
7. NaI (Tl) survey meter, 8. Neutron survey meters,
9. Tritium survey meter, 10. Data analyzer (laptop computer),
11. Electrically driven rover rack

Fig. 1 Redesigned on-site radiation monitoring cart.

The newly designed monitoring cart is a battery-assisted pushcart, whose dimensions are 136 cm wide, 132 cm high and 77cm deep. Its weight was 313.5 kg. Its dimension is one size smaller than the previous one and weight was reduced by half and can move with a maximum operating speed of 2.3 km/h in the forward direction and 1.5 km/h in the backwards direction. The turning radius of the cart is approximately 120 cm. The new housing unit includes five drawers. In Fig. 1, drawers (a) and (b) are for storing the samples obtained by the liquid scintillation counting (LSC) system and ABM system. The samples set in the drawer case are automatically sent to the detection element and measured sequentially. Drawer (c) is for the consumables, which includes the sample vials, sample plates, smear paper, a bottle of liquid scintillation cocktail, and so forth. Drawer (d) is used to store the tritium survey meter and the germanium spectrometer. Drawer (e) is used to store the two dust samplers.

It is conceivable, however, that the removal of shielding materials will result in degrade of detection limit. So the detection limits of the cart were evaluated by comparing them with the legally stipulated limits to determine whether the redesigned monitoring cart could be used to measure radiation dose, radioisotope surface contamination, and radioisotope concentration in air regulated by the Japanese radiation law. Results are summarized in Table 1

Table 1 Performance evaluation of redesigned monitoring cart.

Measurement item	Radiation or Nuclides	Apparatuses installed	Detection limit	Detection limit/ Legal limit	
				Work place	Controlled area
Radiation dose (μSv/h)	γray	NaI(Tl) scintillation	0.1	4.00E-03	4.00E-02
	Neutron	Neutron survey	0.01	4.00E-04	4.00E-03
Radioisotope surface contamination (Bq/cm2)	Arpha	ABM system	0.0419	1.05E-02	1.05E-01
	Others		0.0422	1.06E-03	1.06E-02
Radioisotope concentration in air (Bq/ cm3)	3H	Tritium gas monitor	1.10E-02	2.20E-02	2.20E-01
	3H	Tritium and carbon air sampler and LSC system	5.10E-05	1.02E-04	1.02E-03
	14C		3.32E-05	8.30E-04	8.30E-03
	32P	Dust sampler and ABM system	6.10E-05	8.71E-03	8.71E-02
	35S		6.10E-05	3.05E-03	3.05E-02
	60Co	Dust sampler and Ge-spectroscopy system	2.07E-06	2.07E-03	2.07E-02
	131I		1.20E-05	1.20E-02	1.20E-01
	134Cs		8.52E-06	4.26E-03	4.26E-02
	137Cs		8.52E-06	2.84E-03	2.84E-02

It is concluded that, from Table 1, the radiation detection limits of respective devices are sufficiently lower than the legal limits and then the new cart has performance enough to be used for on-site radiation monitoring in work places and radiation controlled areas in radiation facilities.